DOE/GO-102001-1165
NREL/BK-710-29267
May 2001

5.4.2 Electronic Ballasts

Electronic ballasts (sometimes called solid-state ballasts) are efficient replacements for standard magnetic ballasts. Since the lamp and ballast form a system, lamps are generally changed at the same time ballasts are upgraded. Used with the proper fluorescent lamps, electronic ballasts provide energy-efficient lighting while eliminating the flicker, hum, and poor color rendering associated with older fluorescent lighting. Electronic ballasts capable of driving up to four lamps are available. These will continue to drive three lamps even after one has failed. Some electronic ballasts can also be dimmed, although this generally requires an additional low-voltage control circuit.

Opportunities

Investing in new fixtures with electronic ballasts should be considered if the existing lighting system (1) is old and prone to failure; (2) is inappropriate for current and future use; (3) is kept on for many hours per day; (4) produces flicker, glare, or other discomforts for occupants; (5) causes problems with sensitive electronics in the facility; or (6) produces lighting levels that are either too low or too high. All the fixtures in an entire area are often redone at the same time to save on installation costs and to achieve an integrated design. However, if the original fixtures are in good shape and well suited to an area's needs, it may be possible to replace just the ballasts and lamps.

Technical Information

In 1988, only 1% of the 75.7 million ballasts shipped in the United States were electronic; in 1998, 38% of the 104 million ballasts shipped were electronic. In 2000, DOE issued a new ballast standard that will require high-efficiency electronic ballasts in all new commercial fixtures manufactured after April 1, 2006, and electronic ballasts for most replacement applications after July 1, 2010.

Ballast specifications include:

- Input voltage (usually 277 or 120 VAC)
- Number and type of lamps powered per ballast
- Power factor
- Total harmonic distortion (THD)
- Circuit type (instant-start or rapid-start; series or parallel operation)
- Lamp operating frequency (kHz)
- Ballast factor (BF)
- Ballast efficacy factor
- Minimum starting temperature
- Rated life in hours

Guidance for specifying these and other parameters is available from the National Lighting Product Information Program of the Lighting Research Center.

Instant-start electronic ballasts are slightly more efficient than rapid-start ballasts, but they result in some degradation of lamp life (instant-start operation generally reduces lamp life by about 25%—typically yielding a 15,000-hour life instead of 20,000 hours). Rapid-start operation is usually required for reduced-output ballasts and dimming ballasts. Parallel operation is generally preferable to series operation. If one lamp fails with a parallel-circuit ballast, the other lamp(s) will continue to operate. With series operation, neither lamp will operate if one fails.

Dimming is available as an option for some electronic ballasts. These are always of the rapid-start type, and the dimming ballast will generally have two extra wires for a low-voltage control signal (typically 0–10 VDC). By connecting a simple wall-mounted potentiometer to the low-voltage control wiring, an occupant can control light levels between about 10% (depending on product) and 100% of maximum light output. Alternatively, the control wires can be connected to a ceiling-mounted photocell that adjusts the electric light level to supplement available daylight, thus saving energy (see *Section 5.4.4 – Lighting Controls*).

Power factor indicates how effectively the input power and current are converted into usable watts of power delivered to the ballast. High-power-factor ballasts reduce current loads on building wiring and transformers. Specify high-power-factor ballasts (power factors of 0.90 or higher).

> Ballasts manufactured before 1979 probably contain polychlorinated biphenyls. PCBs are hazardous because they cause cancer, do not readily break down in the environment, and bioaccumulate in plant and animal food chains. PCB-containing ballasts must be disposed of properly in a hazardous-waste or ballast-recycling facility. Ballast-recycling firms salvage reusable metals, reducing the volume of PCB-containing material for disposal.

Ballast factor quantifies the light-producing ability of fluorescent lamps relative to a laboratory reference ballast. For electronic ballasts, the BF can range from about 0.7 to 1.5. It usually makes sense to specify a BF between 0.85 and 1.0 to maximize light output from a specific lamp/ballast combination without overdriving the lamps (which can shorten lamp life). A ballast may have one BF for standard lamps and another for energy-efficient lamps.

☑ One way to significantly reduce energy costs in overlit spaces is to replace existing magnetic ballasts with reduced-output T-8 electronic ballasts (with a BF of 0.70) and relamp with T-8 lamps. Although the T-8 lamp output will be reduced 30% from the rated value, the new levels will be more appropriate, and more energy is saved than with "normal" BF ballasts.

Ballast efficacy factor is the ratio between light output (lumens) of lamps operating on a ballast divided by the input wattage to the ballast. Ballast efficacy factor is useful in comparing ballasts within a given type of lighting system—for example, for the class of 4-foot fluorescent lamps.

Total harmonic distortion defines the effect a device has on the ideal electrical sinusoidal waveform. Harmonics within a facility can cause problems with electronic and communications equipment, can overload transformers, and can cause unexpected loading of the neutral in a three-phase system. Although other equipment can be responsible for harmonic distortion, ballasts are often blamed for these power-quality problems. To avoid problems, specify ballasts with a THD of 20% or less. Ballasts with a THD of 5% or less are available for areas with sensitive electronic equipment or other special needs.

Specify electronic ballasts with the following performance, unless there is a reason to do otherwise:

- Ballast factor: 0.85 to 1.0
- Power factor: greater than 0.90
- Total harmonic distortion: less than 20%

Ballasts capable of operating four lamps can be wired to lamps in several fixtures, saving both initial equipment costs and operating costs.

✋ Many ballasts have a minimum starting temperature rating of 50°F (10°C), and may not be suitable for unconditioned locations. Other ballasts offer low-temperature starting down to 0°F (-17°C).

References

Guide to Specifying High-Frequency Electronic Ballasts, November 1996, and *Electronic Ballasts – Specifier Report*, May 2000, National Lighting Product Information Program (see contacts below). Guides available as downloadable pdf files: www.lrc.rpi.edu/NLPIP.

Lighting Waste Disposal (EPA 420-R-94-004), Office of Air and Radiation, U.S. Environmental Protection Agency, 1994.

Energy-Efficient Lighting Catalog, Defense Logistics Agency, 1996. A good source of equipment information.

Lighting Technology Atlas, E Source, Inc., Boulder, CO, 1997; (303) 440-8500; www.esource.com.

Contacts

National Lighting Product Information Program, Lighting Research Center, Rensselaer Polytechnic Institute; (518) 276-8716; www.lrc.rpi.edu/NLPIP (manufacturer-specific ballast data available online).

FEMP's ballast specifications are available from the FEMP Help Desk at (800) DOE-EREC (363-3732).

EPA ENERGY STAR® Buildings/Green Lights Program Customer Service Center has information about ballast disposal at (202) 775-6650; www.epa.gov/energystar.

Defense Logistics Agency, Defense Supply Center, Richmond, VA; (800) DLA-BULB; www.dgsc.dla.mil.

Association of Lighting and Mercury Recyclers, 2436 Foothill Blvd., Suite K, Calistoga, CA 94515; (707) 942-2197.

☑ To avoid significantly reducing ballast life, promptly replace fluorescent lamps that strobe or have blackened ends.